Address of the President, Sir J. J. Thomson, O.M., at the Anniversary Meeting, November 30, 1916.

It is a pious custom, hallowed by long usage, that your President at the Anniversary Meeting should begin by paying, on behalf of the Society, tribute to the memory of those of our members who have been taken from us since our last Meeting. This year our losses have been almost unprecedentedly severe, and are so numerous that it is impossible, in the time at our disposal this afternoon, to describe at all adequately the work those we have lost have accomplished, and their manifold claims to our respect; for this we must look to the Obituary Notices which have been, or will be, published by the Society. My words must be few and inadequate.

Shortly after the last Meeting, by the death of the Right Hon. Sir HENRY ENFIELD ROSCOE, we lost one who, for more than half a century, had been foremost in promoting the interests of Science and Education. He was renowned not only for his researches, but also for his success as a teacher and expositor; he organised at the Owens College, Manchester, a school which was for long the most important centre of research in chemistry in this country.

As a student at the Owens College in the seventies I have a vivid recollection of the influence he exerted on the development of what is now the Victoria University of Manchester, as well as on the extension of the chemical industries of the district. He was a wise and unbiassed counsellor, ever ready to help in any project which he thought would improve the condition of the country.

By the death of Sir WILLIAM RAMSAY we have lost a chemist whose discovery of the rare gases in the atmosphere has been among the greatest contributions made by this country to science. The founder of a great school of research at University College, a great teacher, a man of unbounded energy and remarkable independence of judgment, his loss, while full of vigour and ideas, has deprived English Science of one of its greatest personalities.

Dr. HENRY DEBUS was a veteran of veterans among teachers of chemistry, and had been a Fellow of the Society for more than fifty years.

Prof. SILVANUS THOMPSON had for long played a prominent part in the development of electrical science in the country, he was a man with many gifts, literary and artistic, as well as scientific, a most successful teacher, and a remarkably clear expositor, whether with tongue or pen. He had an unrivalled knowledge of the literature of physics, which enabled him to

render invaluable service to the Society as Chairman of the 'Catalogue of Scientific Papers.'

In Mathematics we have lost Dr. BENJAMIN WILLIAMSON and Prof. ESSON, who combined with their mathematical knowledge powers of organisation and administration which made them play a great part in their respective universities.

The University of Edinburgh, as well as our Society, suffered a severe loss by the death of Sir WILLIAM TURNER. In addition to being a great anatomist, he was a man of much influence and a very successful administrator, and was for many years foremost in all questions relating to Scottish universities.

Medical science has lost Sir VICTOR HORSLEY and Sir WILLIAM LAUDER BRUNTON. Horsley was a pioneer in the surgery of the brain, and showed all the surgeons of the world how to operate on the brain and spinal cord. He gave his life to help his country in this war, going to give much-needed help to our troops at the front in Mesopotamia, and there he died at Masara, in July. Lauder Brunton was renowned for his contributions to medical science and for his skill as a physician.

The death of Dr. KEITH LUCAS through an accident, when flying, adds another name to the Roll of Honour of Fellows of the Royal Society who, during the war, have lost their lives in the service of the country. At the beginning of the war he joined the Royal Aircraft Factory at Farnborough, and devoted his remarkable inventive power to making improvements in the equipment of aeroplanes; in this work he was very successful. He possessed unrivalled powers of design in physical apparatus for the investigation of physiological problems, and this faculty enabled him to make researches in regions of physiology which were beyond the reach of other workers. He delivered the Croonian Lecture in 1912. His death leaves a gap in physiological science, and in the circle of his friends, which it will be difficult indeed to fill.

Physiology has sustained another loss by the death of Prof. BRODIE, of the University of Toronto, who made important investigations on the kidney, of which he gave an account in the Croonian Lecture for 1911.

By the death of the Right Honourable Sir JAMES STIRLING, a Senior Wrangler, for many years a judge in the Chancery Division, and from 1900 to 1906 a Lord Justice of Appeal, we have lost a wise counsellor, and one who was ever ready to help the Society with his legal knowledge and experience.

Mr. ROLAND TRIMEN, a Darwin Medallist, and at one time Curator of the South African Museum, was well known both for his own researches in natural history and for his association with those of Darwin and Wallace.

Dr. SCOTT, formerly Secretary to the Meteorological Council, had been for long closely associated with the progress of meteorological science in this country.

Sir WILLIAM HENRY POWER, K.C.B., for some time Medical Officer to the Local Government Board, was a leading authority on the question of public health, and received the Buchanan Medal in 1907. There are few, if any, in this country who have done more than Sir William Power to advance the cause of scientific hygiene.

Sir CLEMENTS MARKHAM was one of the veterans of Arctic exploration, and a former President of the Royal Geographical Society.

Prof. JUDD was a distinguished geologist who was for long Professor at the Royal College of Science.

Prof. H. H. W. PEARSON, whose name appears both in the list of newly-elected Fellows and the Obituary list, was an enthusiastic botanist, whose premature death will be a great blow to the progress of botany in South Africa, where he was a professor.

Mr. CHARLES BOOTH rendered great services to the country by his remarkably interesting and important investigations on Social Statistics.

By the death of Prof. METCHNIKOFF, a Foreign Member and Copley Medallist of the Society, Science has lost a great leader and France one of her most eminent citizens. He will ever be remembered by his investigations on inflammation and on immunity to infective germs and the poisons produced by them. To quote the words of Sir Ray Lankester, "he was especially honoured and revered by every Zoologist in the world, for it was to him that we owed the demonstration of the unity of biological science and the brilliant proof of the invaluable importance to humanity of the structure and laws of growth of the lower animals, which he had pursued from pure love of the beauty and wonder of the intricate problems of organic morphology."

The death of Prince GALITZINE and Prof. BACKLUND has deprived our ally Russia of two of the most prominent and distinguished of her men of science.

Prince GALITZINE, who died shortly after election as Foreign Member, had, it is hardly too much to say, revolutionised the science of Seismology, while Dr. BACKLUND, the distinguished head of the great observatory of Pulkowa and renowned for his researches on Encke's comet, had many warm friends in this country and rendered great services to the English astronomers who went to Russia to observe the eclipse in 1914.

Besides those who have been removed by death from the roll of the Society, there are some who have lost their lives while fighting for their country, whom we had hoped at no distant date to welcome into the Society and thereby mark our appreciation of the services they had rendered to science.

I can mention but two names: Mr. GEOFFREY SMITH, whose contributions to biology had marked him out as one to whom that science would owe much, and Prof. MCCLAREN, the author of valuable investigations on the difficult problem of the Equipartition of Energy. Of these and other young men of science fallen in the war we may say in the words of Dr. Montague James, "Many and diverse were the hopes and expectations we had formed for them, but every one of these has been surpassed by the event. They have all been found capable of making the greatest denial of self that men can make; they paid away their own life that the life of their fellows might be happy."

During the past year the work of the Society as a body as well as that of its members individually has been concentrated on problems connected with the war.

The Physiological Committee has done important work on the food supply of the country.

The Engineering Committee have been busy with applications of their science to Naval and Military purposes; the Chemical Committee with the preparation of substances of which the supply has been interrupted by the war.

The Society has been entrusted with the difficult task of selecting those chemists whose services could be employed more advantageously in chemical work than in active service at the front. The Society has also compiled a register of trained scientific workers which has proved exceedingly useful in finding men competent to attack the many scientific investigations demanded by the war.

The National Physical Laboratory has during the past year been working at high pressure on investigations of great importance to the country at this crisis.

Apart from the work of the Society as a body, very many of our Fellows have since the war began been engaged with investigations directly connected with it. The resources of almost every laboratory in the country have been employed on work intended to be of service to our Army or Navy. The number and nature of these researches is striking evidence of the extent to which even the most recondite branches of science can find application in modern warfare. Many of these investigations are of extreme difficulty, effects have to be detected amidst the noise of a battleship or the din of an engagement which it would formerly have been thought somewhat of a feat to measure in the quiet of a laboratory. The work, too, has to be done as a race against time, and when, from conditions arising from the war, apparatus and assistance are very difficult to obtain. I think the experience we have

gained in the past two years points very strongly to the desirability of having as part of the permanent establishment of both the Army and Navy, special laboratories, properly equipped and in close touch with the services, whose work should be the discovery and development of applications of Physical, Chemical, and Engineering Science for Military and Naval purposes. The cost of modern warfare is so great that the expense of these laboratories over long periods of peace would be more than recouped if they succeeded in saving a single battleship or ensured the success of an attack.

Second only in importance to questions connected with the successful prosecution of the war is the question how best to remedy those defects in our industrial organisation and educational methods which have been revealed under the stress to which the country has been exposed by the war. Many of these are closely connected with science but they are no less closely connected with economic and political considerations. For example, we have been taught by bitter experience that it is not safe to have regard to nothing but money profit in developing the industries of the country, we have to recognise that the possibility of the country being attacked by bitter and powerful enemies is one that cannot be lost sight of, and that when this happens it makes a great deal of difference to the strength of a country whether the energies of its people have been directed to production or to importing and selling on commission the productions of the enemy. We cannot, however, produce everything, and the selection of what we should produce is a vital one and depends as much upon economic and political considerations as upon purely scientific ones.

It is, I think, important in any consideration of this subject to remember the duality of this question, for the kind of scientific training required for those who are to develop these industries will depend upon the industries selected, and we must arrange this training so that it is appropriate to the industrial conditions—it is no use making ammunition if it will not fit the guns. It may, for example, require some changes in our industrial organisation to get the full benefit of the application of scientific research to our industries. There are probably but few firms in the country but would benefit from an increase in the research work they undertake, and this not only from the commercial value of the results obtained, but from the spirit of vigour, youthfulness, and independence which successful research brings in its train.

We must remember, however, that many of the most important lines of research in applied science may require such an expenditure of time and money as to be beyond the powers of any firms which have not quite exceptional wealth and resources, and even with these, the English impatience at any

expenditure which does not show a clear prospect of an early return, together with a wide prevalence of a lack of intensity of faith in the certainty of obtaining any results by the application of scientific methods, would make it difficult for even a powerful company to carry its shareholders with it in undertaking a research which might take many years' labour and great expenditure before any profit was obtained. It would seem that for research to have its full effect on our industries, associations must be formed among those engaged in any particular industry—developments of the idea which is embodied in the old Trade Guilds and City Companies—and that one of the primary functions of these associations should be research for the benefit of the industry, carried out in Institutes connected with the association. There are fortunately indications that the formation of associations is already under consideration in certain industries.

We must be careful, however, and I think this might be regarded by the Royal Society as one of its most important duties, that the badly needed increase in research in applied science is not accompanied by any slackening off in research in pure science, that is, research made without the idea of commercial application, but solely with the view of increasing our knowledge of the laws of nature. Even from the crudest utilitarian point of view, nothing could be more foolish than the neglect of pure science, for most of the great changes that have revolutionised or created great industries have come from discoveries made without any thought of their practical application. It may seem paradoxical, but I think it is true, that, the more remote an investigation appears to be from the regions which appear most promising from the point of view of the established industrial practice of the country, the greater are the effects it may produce on the industries of the country. Applied science may lead to reform in our industry, it is to pure science we must look for revolutions. It is not the improvement of old ideas, but rather the discovery of new ones, which produces the most revolutionary effects.

It is often said that in this country we have been slow in seeing the possibilities, for industrial purposes, of new discoveries in pure science, and I am afraid there is some truth in the accusation. One of the reasons for this is, I think, that there has not in the past been sufficient co-operation between the workers in pure science and those who are responsible for the control of our great industries. By such co-operation I do not mean that the physicist or chemist should work himself at any industrial application of his discoveries; he is wanted for other things, and there are others familiar with the industry who could work out the application far more effectively. What I do mean is that, if possible application of a discovery occurred, say to a physicist, it should be easy for him to go to the proper quarters and be able

to point out the possibility to those best able to carry it into effect. One of the objects of the newly formed Conjoint Board of Scientific Societies is to promote closer union between workers in pure and applied science.

One difficulty connected with these plans for reconstruction after the war is, I am afraid, formidable. They all require a large increase in the supply of able and well trained workers. Now, where are they to come from? Already before the war the demand exceeded the supply; since the war training for the scientific professions has necessarily ceased, and many of those who had been trained have fallen. We are faced with the position that the demand will be increased when the supply is below even the normal amount. We must tap new sources of supply. The only source I can see likely to yield an adequate number is the elementary schools of the country. We must try if we cannot "comb" out, to use the word of the moment, from these schools all the boys able to profit by further training, and try to prevent them drifting into employment of secondary importance to the State. There is at present lamentable leakage between primary and secondary schools, and also from the secondary schools themselves, for which the State is, to a considerable extent, responsible. It considers with great care the kind of training to be given in our elementary schools, but when a child has been through this training it gives no guidance whatever as to how it can best be used for the service of State. We want badly some machinery for instructing people what best to do with their children after passing through the primary school. Something which will point out as simply as possible the callings open to them, the training required for these, the assistance which the State would give, if necessary, towards this training, and the opportunity for employment and remuneration after the training has been completed. We want to make the advantages of secondary education much more tangible than they are at present. The position with regard to the supply of adequately trained workers is critical, and calls for earnest and immediate attention.

I now pass on to the most gratifying part of our proceedings this afternoon, the award of the medals.

The Copley Medal is awarded to Sir James Dewar. For more than fifty years he has been indefatigable and most successful in his efforts to increase natural knowledge. In collaboration with Dr. Liveing he made long and most important series of spectroscopic investigations, which have recently been published in a collected form. His well known long continued investigations on the liquefaction and solidification of gases have been one of the most striking features of modern science. Not only has he

taught us how to liquefy gases on a large scale, but he has made notable investigations on the properties of matter at the low temperatures which can only be obtained by their use. His investigations on specific heats of elements at low temperatures, and those made with Dr. Fleming on the effects of low temperatures on the resistance of metals, have yielded most interesting and suggestive results.

Many of the most interesting and important investigations made in Physics in recent years would have been impossible but for his invention of the method of obtaining very high vacua by the use of charcoal immersed in liquid air or hydrogen.

The nation owes a debt of gratitude to Sir James Dewar for his unwearied work, which the Royal Society tries to acknowledge by awarding him the Copley Medal.

The Rumford Medal has been awarded to Prof. William Henry Bragg for his researches into the nature and property of the rays from radioactive bodies and on other kinds of ionising radiations.

His experiments on α-rays threw a new light on the nature of the absorption of α-rays by matter and showed that the α-rays from each radioactive transformation have a definite and characteristic range depending on their initial velocity.

Lately Prof. Bragg, working in collaboration with his son, Mr. W. L. Bragg, has made most important investigations on the interference spectra of X-rays reflected from crystals; these investigations, which formed the subject of the Bakerian Lecture, 1915, have led to a method of great beauty and power for the investigation of the molecular structure of crystals, which has already yielded results of the first importance.

A Royal Medal has been awarded to Prof. Hector Munro Macdonald for his researches in Mathematical Physics.

Prof. Macdonald is the author of an important series of papers on the diffraction of electrical waves by a large spherical obstacle, a problem which is of especial importance in connection with the transmission over the earth's surface of the waves used in wireless telegraphy. He has also made a valuable contribution to the theory of Bessel's functions and has obtained results which promise to have important applications to some problems in Mathematical Physics.

His work has extended over a wide range, for, in addition to his work on electrical waves, he has made valuable contributions to Hydrodynamics, Elasticity, and Optics.

The other Royal Medal has been awarded to Dr. John Scott Haldane for the important contributions he has made to Physiology, especially on the

subject of respiration. His studies of the combination of carbon monoxide with hæmoglobin have been fruitful in many directions. They led him to the investigation of gas explosions in coal mines, which has had important results in the saving of life in mines. He has also studied the effect of high temperatures under varying conditions of moisture on the human body, and was the first to lay down the definite conditions under which it is possible to withstand high temperatures or to work in them.

His work shows the rare combination of a wide philosophic insight into fundamental problems with the power of applying the knowledge gained from scientific researches to the every-day needs of the community.

The Davy Medal is awarded to Henri Louis Le Chatelier, who, as the result of much investigation, introduced the Le Chatelier thermo-electric couple and inaugurated a new period in the measurement of high temperatures. In co-operation with M. Mallard he made extensive investigations on the ignition and explosion of gaseous mixtures, in which several principles of first-rate importance were established. He was one of the pioneers in micro-metallurgy and one of the first to introduce exact methods and clear ideas into the science of industrial silicates. His work has been carried out in close relation to the practical application of science, and his discoveries have been of great industrial importance.

The Darwin Medal is awarded to Prof. Yves Delage for his important investigations on the development of Sponges and for his contributions to Biology and Zoology.

The Sylvester Medal is awarded to Prof. Jean Gaston Darboux, Perpetual Secretary for Mathematical Sciences to the Academy of Sciences, one of the most distinguished of contemporary French Mathematicians. He has published work of the first importance on the Theory of Surfaces, the Theory of Partial Differential Equations, Kinematics, and the Planetary Theory.

The Hughes Medal is awarded to Dr. Elihu Thompson, one of the pioneers of Electrical Engineering, for his important contributions to that subject.